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## INDUSTRIAL UTILIZATION OF SOUTHERN FARM CROPS

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Large-scale industrial utilization of farm crops has been for several decades the dream of many people interested in agriculture. This interest has been intensified during periods of burdensome surpluses, and as you all know there have been recurring burdensome surpluses within the past 15 years in some of the basic farm crops, such as cotton. Such conditions have carried this interest to a point where formal and organized action is now being taken to increase the industrial utilization of farm crops. In various parts of the South there are now in existence several research laboratories actually engaged in research programs in this comparatively new field. Some of these laboratories are operated as part of university research programs; some by state governments; some by private or semiprivate organizations; and some by the Federal Government. Of these various organizations, some are conducting fundamental and applied research on the growing of farm crops for industrial use; others are doing analogous work in the field of utilization; and still others are carrying on promotional work to educate consumers and attract capital to manufacturing possibilities. Each type of activity has its place; each is necessary; and, for maximum progress, considerable cooperation should be maintained between these groups.

As many of you know, the Southern Regional Research Laboratory in New Orleans, with which I am connected, is a federal research laboratory operated by the Bureau of Agricultural and Industrial Chemistry of the Agricultural Research Administration, U. S. Department of Agriculture, for the purpose of increasing the industrial utilization of southern agricultural commodities. In order to show you that we are well equipped to cope with the huge problems ahead of us, I ask your indulgence while I give you a brief picture of our organization. Our physical plant is composed of a four-story, U-shaped main building and an associated power plant. The main building is 212 feet along the front or base of the U and 368 feet along the sides. One wing is equipped with 72 laboratories, while the other wing is designed to house our pilot plant equipment. Inside the pilot-plant wing, there has been erected a small cotton mill, 95 feet long by 65 feet wide, which occupies three floors. This experimental mill is completely air-conditioned with an individual air-conditioning unit for each floor so that the temperature and humidity can be varied in one room without affecting any other section of the mill. The degree of control for both temperature and humidity is greater than that of the best air-conditioned offices. To provide such a high degree of atmospheric control is, I assure you, very expensive. Our purpose in this construction was to make possible the exact reproducibility of results and their application in the cotton textile industry. Besides being able to reproduce

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1/ Presented before the Southwestern Chemurgic Conference, Oklahoma City, Oklahoma, May 18, 19, 20, 1944.

2/ This is one of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

results of experimental runs, we desire to be able to make runs under various controlled conditions representing the climate prevailing in particular localities throughout the cotton-manufacturing belt. This experimental mill includes modern standard textile machinery for all steps in the manufacture of cotton fabrics, from opening through weaving, and the necessary auxiliary equipment, such as that used for winding and warping. Connected with the mill, we have a modern testing laboratory equipped with machines for making a wide variety of physical tests on textiles.

In addition to the cotton mill we have in this pilot plant wing a pilot-plant starch factory, an oilseed crushing plant, and an eight-cell extraction battery in which several hundred pounds of goldenrod rubber were produced during the past few months.

In our organization, we have a very well trained staff of chemists, physicists, bacteriologists, biochemists, chemical engineers, mechanical engineers, and cotton technologists, totalling over 175. We are very proud of our Southern Regional Research Laboratory, and I wish to extend to all of you an invitation to visit it when you are in New Orleans. I also want to assure you that we are appreciative of research suggestions within the scope of our authority.

When plans were made for our research program, the southern agricultural commodities, cotton, sweetpotatoes, and peanuts, were selected for initial attention. Cotton was selected, mainly, because of the acute surplus problem, and peanuts and sweetpotatoes were selected, primarily, because they seem to be the products of this region most adaptable to industrial utilization. The Department of Agriculture realized that there are other southern farm commodities which offer opportunities for industrial utilization, but it also realized that, if our efforts were spread over too broad a field at one time, the effectiveness of the entire program would be reduced.

In regard to our present research, all of you realize that, for the "duration", war needs control the objectives of research as well as all other efforts of the Nation. Even before December 7, 1941, a large portion of the research program was on problems relating to national defense. After Pearl Harbor, the program was revised to concentrate all our research efforts upon problems directly connected with the Nation's war effort. For the most part, this research deals with the development of products to replace or supplement others usually made from imported commodities or from scarce domestic commodities. Much of this work was undertaken at the request of our national war agencies.

In this group of requested research projects, information and experimental data are restricted so that I can give you little more than descriptive titles of the projects. This is especially true of our research projects on cotton. The Southern Regional Research Laboratory has made a contribution to the war effort by improving the stability of nitrocellulose and by modifying cotton fiber to permit its substitution for other fibers. We are actively engaged in the permanent fireproofing of cotton army fabrics as well as the production and application of special finishes to improve the strength-weight ratio and durability of high count military fabrics. One

of our oldest war projects is the development of a suitable rotproofing treatment for extending the life of sandbags, especially cotton sandbags. This work was undertaken at the request of the Corps of Engineers. We are testing all the commercial materials offered to the Corps of Engineers and are developing new and more effective preservative treatments and more satisfactory testing procedure. I am very happy to quote a statement received from the Camouflage Branch of the Engineering and Development Division of the Corps of Engineers, which was made less than a month ago, which reads: "It is the desire to again express our appreciation for the splendid research work which you and your staff at the Southern Regional Research Laboratory have done for the Corps of Engineers in the evaluation of fungicides and to assure you that the data you have furnished has been put to practical and effective use in the war effort."

The Southern Regional Laboratory has also developed an improved cotton bandage fabric. The new fabric has interesting and valuable properties, including: a high degree of stretchability, which makes the bandage partly self-fitting; some elasticity, which makes it self-tightening to a certain extent and very flexible when in place; and a roughened surface, which keeps it from slipping. All of these properties are retained after the usual sterilization necessary for products of this kind.

Clinical tests with this new bandage fabric have been conducted in a number of local hospitals in New Orleans, including the U. S. Naval Hospital. A report from the Naval Hospital, received in February of this year expressed the opinion, based on six months' experience with this bandage fabric, that it is superior to regular gauze bandage for special work; it stated that the fabric could be sterilized without affecting its elasticity, and had been found particularly desirable in head, knee, arm and elbow dressing. The greatest quantity of this special bandage fabric was used by the Orthopedic Department of the Naval Hospital. This hospital stated that there is a definite need for this type of bandage and that it would encourage the continuance of its development.

We are now very actively engaged in efforts to produce a superior and heat-resistant cotton tire cord. Although laboratory tests have shown that rayon tire cord has better heat resistance than ordinary commercial cotton tire cords, certain types of modified cotton cord compare very favorably with rayon tire cord in heat resistance. In other words, heat resistance is not a unique property of rayon. Last October, through the cooperation of the Tank and Automotive Center of the Ordnance Department, tires made with our improved low-gauge cotton cord were tested at the Normoyle Proving Ground, Texas, and later at the Desert Testing Station at Camp Seeley, California. At the present time, by another directive from the Tank and Automotive Center, tires have been fabricated from our intermediate-gauge cotton cord and will be tested shortly at Camp Normoyle. The Southern Laboratory is spinning the yarns for a special cotton cord to be made by a manufacturer in Georgia and used in the fabrication of truck tires by two tire companies under a directive from the Office of the Rubber Director, of WPB, for tests by their GTF fleet.

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There have been some developments in our peanut research work which I think you will find interesting. Peanut oil, owing to its comparatively high stability when properly expressed and refined, should be an excellent oil for use in the manufacture of mayonnaise and salad dressing. However, for use in these products an oil must be either a natural "winter" oil like corn oil, or capable of being "winterized" to produce a "winter" oil, as in the case of cottonseed oil. Peanut oil cannot be winterized by the usual commercial winterization process, because on being cooled to a low temperature it tends to produce a mushy product which cannot be separated by filtration. Because of this property, peanut oil is excluded from the salad oil market which last year (1942-43) consumed 225 million pounds of oil.

A laboratory unit for solvent-fractionation or solvent-winterization was developed and operated. In this small apparatus, having a capacity of 1 to 2 lbs. of oil per charge, the winterization of peanut oil was effected, and an excellent oil for the manufacture of mayonnaise and other salad dressings, and for general table use, was obtained. This process of solvent winterization, when applied to cottonseed oil, is effective in one hour and fifteen minutes, as compared to 4 or 5 days for the present commercial winterization process for cottonseed oil.

When solvent winterization is combined with hydrogenation, it is possible to prepare a "tailormade" olive oil substitute from peanut oil for industrial uses. Samples of this "tailormade" oil have been tried out by the National Wool Manufacturer's Association, which reported that it is actually superior to olive oil as a lubricant in spinning worsted yarns. With our methods of hydrogenation and solvent winterization, we are also able to produce a number of other fat substitutes including a cocoa-butter substitute which is creating considerable interest in the vegetable-oil industry.

Also, we have been carrying on interesting research work on peanut protein. Considerable success has attended our efforts to develop adhesives from peanut proteins and peanut meal. We were especially interested in producing tacky and rewettable types of adhesives. The market for rewettable glues is enormous. One adhesive plant which has been cooperating by testing our adhesives, produces seven carloads of gummed tape per day. Our progress was due to the development of a fusible protein that is unique among protein preparations. This product, isoelectric protein hydrate, is fusible at the low temperatures of 40-50° C. Several experimental batches of peanut protein glues have been made and used in the manufacture of gummed tape under normal commercial operating conditions in one of the largest gummed tape plants in this country. These peanut-protein glues compare favorably with animal glues and for certain special purposes are thought to be superior. Some had adhesive values, by the Harnden-McLaurin gummed-tape tester, as high as 75, in comparison with 92 for the standard animal glue for gummed tape. Heretofore, no vegetable-protein glue, commercial or experimental, examined by this same firm has ever given any reading whatever on Harnden-McLaurin tester. Gummed tape glues prepared from peanut protein offer the following advantages: they are light-colored, which is desirable when using white paper; they are

less hydroscopic than animal glue; and they are made from edible material, whereas animal glue is made from inedible material. As you probably know, there is considerable research in progress on the production of artificial fibers from vegetable proteins. If you visit the Southern Regional Laboratory, we will be able to show you some interesting samples of fibers and fabric made from peanut protein.

I would like to give a brief report on our sweetpotato utilization research, along with some of our ideas on the general subject of industrial utilization. We think we are in a position to make these general observations, since the Sweetpotato Products Division of the Southern Regional Laboratory has had for several years the unique position of consultant on technical operations to the only commercial sweetpotato starch plant in the country, the Laurel Starch Plant, which is owned by Sweet Potato Growers, Inc., Laurel, Mississippi.

I am not going to paint a rose-colored picture of opportunities for quick large-scale increases in the industrial utilization of agricultural products. The progress that has been made in the past along these lines has been slow. The reason for this is that the progress is largely dependent on careful research and development, both of which are time-consuming. It is not the simple matter, for example, of discovering that sweetpotatoes contain starch and then setting up plants to extract the starch. That sweetpotatoes contain starch has been known for a long time. The real problem is to grow a particular variety of sweetpotatoes, highest in starch content, at a certain allowable maximum cost per ton, delivered at the plant over a not-too-limited period of time, and to develop methods for extracting from these sweetpotatoes a high-grade starch, having desirable properties for special uses, at a cost that will ensure a commercial market for the starch at a price that will enable the farmer-producer to make a profit on his crop of sweetpotatoes.

This is not an easy problem, especially if all the costs must be defrayed from the sale of one product. The alternative is the development of other sweetpotato products, as well as salable byproducts from sweetpotato manufacture, to carry some of the expense and thus solve the problem and ensure success of the venture. The operation of a plant for the dehydration of sweetpotatoes for food, in conjunction with starch-plant operation, is desirable at this time, because of the relatively high prices which the War Department and Lend-Lease buyers are offering for dehydrated foods. Few persons anticipate prices in this range after the war, when these dehydrated products will face stern competition from other processed foods. In present operations at Laurel, a byproduct pulp feed is produced and finds a ready market; additional byproducts will no doubt be developed. Our research has indicated that, in connection with sweetpotato starch manufacture, feed-protein and feed-yeast can be developed as secondary products with small additional investments in plant equipment. There are, at present, markets for these feeds at prices that would adequately compensate for their production and would, at the same time, materially decrease the overall starch-plant costs. Our research on pectin has indicated the possible commercial recovery of pectin from sweetpotatoes. The general pectin situation,

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however, is such that few people will hazard a guess on the amount of pectin that can be marketed after the war; moreover, there are several cheap by-product sources of pectin.

Although crop utilization research and development work are slow, there have been enough successes in this field to prevent anyone from being too pessimistic. One of the more recent examples is the industrial utilization of soybeans in this country. I think we can expect a greater rate of progress with a wide range of farm commodities in the future. This will naturally follow from the increased emphasis now being placed on this type of research and from the fact that the cumulative knowledge will multiply research effectiveness in dealing with agricultural commodities as raw materials for industrial uses.

Taking advantage of the exceptional climatic conditions in the Florida Everglades, and profiting from the sweetpotato-starch research and development work by the Bureau of Agricultural and Industrial Chemistry, the U. S. Sugar Corporation is undertaking the manufacture of 50 million pounds of sweetpotato starch per year in a large, new plant at Clewiston, Florida. Reports are that this new sweetpotato starch development represents an investment of seven million dollars, all of it private capital. This is an example of successful business men thinking so highly of crop utilization possibilities as to enter this field in a large way. It should be emphasized, however, that in the vicinity of Clewiston, Florida, the U. S. Sugar Corporation will be able to harvest fresh sweetpotatoes for starch processing through the greater part of the year.

The growing of food crops specifically for industrial utilization is in most instances a major problem. In the past or, for that matter, even today agronomic and genetic research has centered mainly on producing crops having properties that make them more suitable for food and animal feeds. Those parts of food crops that have been utilized industrially have usually been the culls, such as cull peanuts for oil and cull white potatoes for starch, but no large-scale industry can develop unless it can be assured of a regular supply of raw material. The availability of culls, which depends on size of the crop as well as on current food and feed demands, is extremely variable from year to year. This would make plant operation spasmodic and capital investment unsafe.

In the case of certain commodities, therefore, we believe agronomic and genetic research should be directed also toward crop production for industrial utilization. The growing of sweetpotatoes for starch, mentioned a moment ago, offers a good example. In the southern states, the average yield of sweetpotatoes for food is less than 100 bushels per acre, whereas the yields of sweetpotatoes for starch are running 200 to 250 bushels in areas that are not classified as highly productive. Yields of 300 to 350 bushels per acre have been reported in sweetpotato areas in Louisiana, while the Florida area and the Rio Grande Valley of Texas have reported much higher yields.

In the food market, uniform size and flavor of sweetpotatoes are of paramount importance, while in the industrial market maximum starch-per-acre, regardless of size, and a type of potato that lends itself readily to starch extraction, are the main considerations. All the sweetpotatoes a farmer raises cannot be sold on the food market. Grading is necessary and this step is apt to be expensive. On the other hand, the starch plant buys field-run potatoes by weight.

When considering industrial utilization of agricultural commodities, we must keep our feet on the ground. Naturally our interest is stirred and we become more hopeful when we are shown samples of beautiful plastics and other products made from common agricultural commodities, but we must not lose sight of the fact that there is usually a big gap between technical possibility and commercial feasibility.

Even if the farmer can assure industry of a regular supply of raw material, the technologist must first show that this material can be manufactured economically into a readily salable product. Here are involved the technical and economic problems of processing, which are based on fundamental research and studies of particular properties required for specific uses.

In comparison with organic mineral products as raw materials for industrial uses, agricultural commodities have both advantages and disadvantages. With regard to disadvantages, agricultural products are, in general, more variable in quality, and their prices fluctuate through a wider range. The use of agricultural products may involve seasonal operation, with inefficient utilization of processing plant equipment, or the solution of difficult storage problems to permit operation over a larger portion of the year. On the other hand, once a demand for agricultural raw material is established, the supply is renewable annually as compared with a diminishing supply of mineral products, with constantly increasing costs, and eventual exhaustion.

More important than these considerations, however, are the reasons why we should attempt to develop industrial uses for farm crops. Probably the most important hinges on the fact that in normal times our farms are over-populated from the standpoint of laborers required to produce food, feed, and fiber crops for domestic consumption and exports. The demands for food, clothing, and shelter vary but little with changes in price. Decreasing prices of agricultural commodities are not quickly checked by increasing demands, and for this reason large fluctuations may occur in the prices of these commodities. On the other hand, the demand for industrial products responds quickly to changes in price. This results in smaller fluctuations in price of industrial products. The industrial utilization of even a small part of a crop each year would have a marked stabilizing effect on its price, and I am sure all of you will agree that such a condition would be most desirable. Since our standard of living is dependent upon the per capita production of wealth (that is, useful goods and services) it is to the best interests of all to stimulate increased production of useful farm commodities. The development of industrial outlets for such agricultural commodities will, we think, serve this purpose.

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We know from the chemical composition and physical properties of almost any agricultural commodity that, in a laboratory, we can convert it into an almost endless number of useful products. The big problem is to discover methods and to design equipment for making these same things on a commercial scale at a certain maximum allowable cost. Research of this nature is slow and costly. Blind alleys leading from initial ideas are the rule in research rather than the exception, requiring a reorientation of ideas and a change of attack before success is reached. Concentrated research on industrial utilization of farm products is comparatively new but, if we can reason by analogy with what research has accomplished in other fields, we can look forward to worthwhile progress in this field, and by "worthwhile progress" I mean progress on a dollars-and-cents basis.

After the war, cotton will have to meet competition from the newer synthetic fibers such as nylon and vinyon, as well as from rayon. Also, we can expect foreign countries to increase their production of a type of cotton which will be highly competitive with American cotton. We will probably have to rely to a greater extent on the domestic markets for American cotton. However, I don't want to give the impression that the situation facing the southern cotton industry is hopeless. With more real research being done on cotton products and the processing of cotton, and with sound educational and promotional programs such as those conducted by the Cotton Textile Institute, the National Cotton Council, and others, the future really looks brighter than it did six, five, or even four years ago. Without any reflection on the textile industry (for they are the first to admit it), we are just beginning to learn how to use cotton intelligently as a raw material. We are learning something about the real importance of the elasticity of the cotton fiber and about what causes deterioration from sunlight, laundering, heat, and other conditions to which cotton fabrics are normally subjected. Cotton products of the future will be better products. They will be more uniform in performance and I hazard the prediction that they will be cheaper.

Returning to the general theme of this discussion, let me summarize our views regarding the future of post-war industrial utilization of southern farm crops with the observation that I believe these views are shared by most of the people working in this field:

1. Increased utilization of agricultural commodities is a worthwhile goal.
2. Research will be the basis of progress towards this goal.
3. Progress will not be quick and spectacular but will be sound. Our real research job is to obtain results that will provide increased industrial outlets for the crops grown on most of our large southern acreage and thus help to utilize the largely increased industrial plant capacity that will be available in the South at the end of this war.